

REMARKS

Restriction

The previous election of Invention I, claims 1-7 is confirmed. Non elected claims 8-20 have been canceled. Applicant reserves the right to file the non elected claims in a divisional application.

Claim Objections

Claims 6 and 7 have been objected to due to the term "the water gas shift reactor". In response claims 6 and 7 have been amended to recite "the shift reactor".

Rejections Under 35 USC §112, second paragraph

Claims 2 and 3 have been rejected under 35 USC 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. In response to this rejection, claims 2 and 3 have been amended to recite " a second heat exchanger/distributor".

Rejections Under 35 USC §102 and 35 USC §103

Claims 1-3 have been rejected under 35 USC 102(e) as being anticipated by Bentley (US Patent No. 7,066,973 B1).

Claims 1, 4, 6, and 7 have been rejected under 35 USC 102(b) as being anticipated by Gondouin (US Patent No. 5,052,482).

Claim 4 has been rejected under 35 USC 103(a) as being unpatentable over Bentley (US Patent No. 7,066,973 B1) and further in view of Grasso (US Patent No. 4,344,850).

Claim 5 has been rejected under 35 USC 103(a) as being unpatentable over Bentley.

The rejections under 35 USC §102 and 35 USC §103 are traversed for the reasons to follow.

Summary Of The Claimed Subject Matter

Claims 1-8 are directed to a hydrogen generator 100 (Figure 1). The generator 100 includes a shell 102 (Figure 1) having an internal conduit with an inlet port 104 (Figure 1) and an outlet port 106 (Figure 1). The generator 100 also includes a reformer 110 (Figure 1) adapted to convert a fuel and steam (or steam and oxygen) into a reformat containing hydrogen and carbon oxides. The generator 100 also includes a shift reactor 114 (Figure 1) in the conduit downstream of the reformer 110 having at least one catalyst stage adapted to convert carbon monoxide in the reformat to carbon dioxide and hydrogen.

The generator 100 also includes a heat exchanger/distributor 134 (Figure 1) in the conduit adapted to cool and inject steam into the reformat. The heat exchanger/distributor 134 (Figure 1) is adapted to vaporize water, to inject steam into the reformat and to cool the reformat. As shown in Figures 2 and 3, the heat exchanger/distributor 134 includes a coiled tube 200 and a separator comprising a riser 202 in the conduit, adapted to receive steam and to remove substantially all liquid water from the steam. The heat exchanger/distributor 134 also includes a steam distributor 206 comprising an arm 204 on the riser 202 having an opening 208 in fluid communication with the riser 202 adapted to pass steam into the reformat.

Claim 1 has been amended to include additional recitations which more clearly distinguish the claimed generator from the prior art. A reading of claim 1 on the specification and drawings is as follows.

1. A compact hydrogen generator comprising:

a shell (**102-Figure 1**) having an inlet port (**104-Figure 1**), an outlet port (**106-Figure 1**) and a conduit (**paragraph [0059]**) between the inlet port (**104-Figure 1**) and the outlet port (**106-Figure 1**) having a diameter (**paragraph [0052]**);

a reformer (**reforming unit 110-Figure 1**) in the conduit adapted to convert a fuel into a reformat comprising hydrogen and carbon oxides (**paragraphs [0033] to [0043] and [0051]**);

a shift reactor (**water gas shift unit 114 or 118-Figure 1**) in the conduit downstream of the reformer spaced by a distance less than about three times the diameter

(paragraph [0052]) having at least one catalyst stage adapted to convert carbon monoxide in the reformat to carbon dioxide and hydrogen **(paragraphs [0041] to [0043] and [0052] to [0054])**;

a heat exchanger/distributor **(134 or 150-Figure 1)** in the conduit adapted to cool and inject steam into the reformat comprising **(paragraphs [0044] to [0046] and [0059])**;

(a) an indirect heat exchanger comprising a coiled tube **(200-Figure 2)** in the conduit adapted to receive liquid water, to vaporize the liquid water to steam, and to cool the reformat in the conduit **(paragraph [0061])**,

(b) a separator comprising a riser **(202-Figure 3)** in the conduit attached to the coiled tube adapted to receive steam from the coiled tube and to remove substantially all liquid water therefrom **(paragraph [0061])**, and

(c) a steam distributor attached to the riser having an opening **(28-Figure 3)** in fluid communication with the riser adapted to pass steam into the conduit **(paragraph [0061])**.

35 USC §102(c) Rejections Of Claims 1-3 Over Bentley et al.

The 35 USC §102(c) rejections of claims 1-3 over Bentley et al. are traversed as the cited reference does not disclose or enable all of the limitations of the present generator. In addition, independent claim 1 has been amended to include additional limitations which further distinguish the claimed generator from the prior art. In particular, claim 1 has been amended to further define the unique structure and function of the heat exchanger/distributor.

Amended claim 1 recites that the heat exchanger/distributor includes a coiled tube 200 (Figure 2) in the conduit. This coiled tube 200 (Figure 2) is configured to perform two functions namely: cooling of the reformat in the conduit, and also conversion of essentially all liquid water in the tube 200 (Figure 2) to steam. The heat exchanger/distributor also includes a riser 202 (Figure 2) in the conduit which separates any remaining liquid water, and a distributor (arms 204-Figure 3) having openings 208 (Figure 3) which pass the steam into the conduit. This construction improves the

performance of the generator because the volume of liquid water in the system remains low, and the catalyst stages can be maintained at optimal operating temperatures.

The steam separator SS (Figure 23) in Bentley et al. does not have the same structure as the presently claimed heat exchanger/distributor, and does not perform the same function. Specifically, the steam separator does not include a coiled tube and riser in the conduit, and does not inject steam into the conduit. Rather, as stated at column 20, lines 3-5 of Bentley et al.: "The water/steam mixture enters a steam separator (SS) before returning water to the water reservoir R and steam to the reformer 12."

In addition to being novel over Bentley et al., amended claim 1 is submitted to be unobvious over Bentley et al. In this regard, the claims *taken as a whole* are submitted to be unobvious over the art *taken as a whole*. With regard to the "riser" feature of claim 1, Grasso was cited as teaching a riser for steam separation. However, the present riser is part of a component which also performs heat exchange and steam distribution. Thus although an individual element of the claimed generator may be known in the art, the claims *taken as a whole* are submitted to be unobvious over the art. A hydrogen generator with the stated combination of a reformer, a shift reactor and a heat exchanger/distributor also provides improved results which is also an indicia of unobviousness.

35 USC §102(e) Rejections Of Claims 1, 4, 6 and 7 Over Gondouin

The 35 USC §102(e) rejections of claims 1, 4, 6 and 7 over Gondouin are traversed as the cited reference does not disclose or enable all of the limitations of the present generator. In addition, independent claim 1 has been amended to include additional limitations which further distinguish the claimed generator from the prior art. As previously argued, claim 1 has been amended to further define the unique structure and function of the heat exchanger/distributor.

The downhole catalytic methanator reactor in Gondouin is several hundred feet long (column 2, lines 40-41), which is not a "compact" hydrogen reactor as presently claimed. Although compact is a relative term, claim 1 has been amended to emphasize the compact size of the generator by stating the shell has a "diameter" and that the shift reactor is located downstream from the reactor by "a distance less than about three times

the shell diameter". Antecedent basis for this recitation is contained in paragraph [0052] of the specification.

In addition, Gondouin does not disclose or suggest a hydrogen generator having a heat exchanger/distributor constructed as presently claimed. The Office Action cites column 13, lines 41-48 as disclosing this element of the presently claimed generator. This passage describes a quench section of coarse ceramic particles 47 in which water tubes 48 are immersed. The Office Action further cites element 18 of Gondouin as being equivalent to the presently claimed separator. Element 18 comprises an injectant collector space (column 9, line 45) which is in fluid communication with a steam separator 19.

Claim 1 has been amended to emphasize the compact structure of the heat exchanger/distributor and to further distinguish from the combination of elements in Gondouin which perform heat exchange and steam distribution. In particular, claim 1 recites a coiled tube in the conduit, a riser attached to the coiled tube and a distributor with an opening attached to the riser. The present arrangement is more compact and simpler than the combination of elements in Gondouin. In addition, the Examiner is again asked to view the claims *as a whole* in assessing unobviousness. Thus although individual features of the generator are known in the art, the combination of elements is submitted to be unobvious over the art.

35 USC §103(a) Rejection Of Claim 4 Over Bentley et al. and Grasso

Claim 4 had previously recited the "riser" feature which has been incorporated into claim 1. Grasso was cited as disclosing a riser on a steam separator. Claim 4 has been amended to recite a plurality of distributors on the riser. This claimed construction is submitted to be novel and unobvious over the art. In addition, claim 4 is submitted to be unobvious for essentially the same reasons as argued above for claim 1.

35 USC §103(a) Rejection Of Claim 5 Over Bentley et al.

Claim 5 has been amended to recite a plurality of distributors comprising arms on the riser. This claimed construction is submitted to be novel and unobvious over the art.

In addition, claim 5 is submitted to be unobvious for essentially the same reasons as argued above for claim 1.

New Claims

New claims 21-25 have been added. Dependent claims 21-22 are submitted to be allowable in combination with claim 1.

New independent claim 23 recites an indirect heat exchanger 160 (Figure 1), and a first indirect heat exchanger/distributor 134 (Figure 1) in the conduit adapted to cool and inject steam into the reformat. Claim 23 also recites a shift reactor in the conduit downstream of the reformer having a first catalyst stage 114 (Figure 1) and a second catalyst stage 118 (Figure 1). Claim 23 also recites a second heat exchanger/distributor 150 (Figure 1) in the conduit between the first catalyst stage and the second catalyst stage adapted to cool and inject steam into the reformat.

New independent claim 23 and new dependent claims 24 and 25 are submitted to be novel and unobvious over the art.

Conclusion

In view of the amendments and arguments, favorable consideration and allowance of claims 1-8 and 21-25 is respectfully requested. An Associate Power Of Attorney, a Petition For Extension Of Time and a Change Of Address For Correspondence are also being filed with this Amendment. Should any issues remain, the Examiner is asked to contact the undersigned by telephone.

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